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ORIGINAL PAPER

Diversity of non-timber forest products in Cachar District, Assam, India

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Abstract: We identified 67 and 21 NTFP-yielding plant and animal species, respectively, in a reserve forest in Cachar district of Assam. We recorded globally threatened species listed by IUCN as Critically Endangered (plant species *Dipterocarpus turbinatus*), Vulnerable (plant species *Aquillaria malaccensis*), Endangered (animal species *Hoolock hoolock*, *Indotestudo elongata* and *Manis pentadactyla*), and Vulnerable (animal species *Nilssonia hurum* and *Rusa unicolor*). The whole plant or animal and/or their various parts were used as food or medicine, in house construction, magico-religious activities and others. While some NTFPs were harvested throughout the year, others were harvested seasonally. A comprehensive NTFP policy, along with scientific measures for regeneration, restoration and augmentation of NTFP-yielding plants and animals, would help in addressing the conflicting demands of conservation and livelihood in the forests of this area.

Keywords: Non-timber forest product (NTFP), Indo-Burma biodiversity hotspot, Assam, IUCN red list, diversity, threatened taxa

Introduction

Non-timber forest products (NTFPs) are objects of biological origin, both plant and animal, derived from the forest and allied land uses for subsistence and cash income by forest dwellers. NTFPs have long been harvested for subsistence and trade (Ticktin 2004). An estimated 50 million economically marginalized forest dwellers in India harvest large quantities of NTFPs for their subsistence as well as for trade (Uma Shaanker et al. 2004; Hegde et al. 1996). An additional 200 to 300 million non-tribals also depend on NTFPs to lesser degrees (Shiva 1995). A 2010–2011 report from the Ministry of Environment and Forests, Government of India, estimated that about 100 million people in India depend on various forest products other than timber, which in turn generates Rs 20 billion in government revenue (TERI 2004). There is strong association between NTFPs and application of traditional knowledge in the harvesting and maintenance of forest products. Throughout the world, the diversity of NTFPs is important to the livelihoods of forest-edge populations. Iqbal (1993) estimated that 4,000 to 6,000 NTFPs are used worldwide and most are harvested from wildlands. In the Upper Amazon region, aboriginals consume 139 species of native fruit, harvested extensively from the forest (Vasquez & Gentry 1989). In North Bolivia an indigenous tribe "Chacobo" uses 75 tree species as NTFPs (Boot 1997). Most of the medicinal and aromatic plant taxa used in the drug industry come from wildlands. In India, 90% of the plants supplied to the international market are from wild stock (Mishra et al. 2009). NTFPs are important in the economies of developed countries as well. For example, 132 species of plants of different habits are used as NTFPs in the Upper Peninsula of Michigan, USA, for commercial sale and self-consumption (Emery 1998). In British Columbia, Canada, 200 different types of NTFPs were identified, of which 50 were used for commercial purpose (Mohammed 1999). In Germany, the number of medicinal plant species in trade is about 1,543, of which 93%–98% come from the forest (Ticktin 2004). In South Asian countries, trade in wildlife and wildlife products is lucrative and diversified and yields expanding sources of income derived from the forest. However, using existing data it is virtually impossible to derive meaningful estimates of trade volume because most of the trade goes unrecorded and available data mostly refer to protected species (De Beer and McDermott 1996).

Because of the rapid decimation of forest resources, particularly NTFPs, preparation of detailed inventories of plant and animal parts and products harvested in a given area is an essential prerequisite for developing appropriate management strategies and action plans (Pandey and Saini 2007). The reason is because NTFPs help to combat poverty among forest dwellers by contributing to their livelihoods, food security, incomes, health,

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sustainable human development in particular, and conservation of forest ecosystems at large (FAO 1995; Joshi and Singh 2010; Uprety et al. 2010).

The Barak Valley region in the southern part of Assam, India, a part of the Indo-Burma Biodiversity Hotspot (Myers et al. 2000) and located in the confluence region of the Oriental and Palaearctic biogeographical realms, is rich in both plant and animal diversity. The forest dwellers in the valley depend on non-timber forest products for their livelihoods, and have been collecting materials including lac, resin, edibles, honey, ivory, bush meat and others for generations (Hunter 1879; Gupta 2000). Dattagupta et al. (2010) described the socio-economic dependence of various forest dwelling communities on NTFPs. In this study, we enlarge the scope of the previous work by describing the diversity of NTFPs harvested in a major reserve forest of Cachar district in Assam, India. We also describe the various plant and animal parts used as NTFPs, and the seasonal patterns of harvest as well as the threats faced by the NTFP-yielding plants and animals. We recommend remedial measures to reduce threats to NTFP-yielding species.

Materials and methods

Study area

The study was conducted in the Inner Line Reserve Forest (ILRF) of Cachar district in the Barak Valley region of southern Assam, India. It is one of the major forests in this region, covering 418.56 km^2. When it was first established through a gazette notification of the Government of British India in 1876, it also included a forest tract in the present day state of Mizoram that covered 570 km^2. Topography is varied, with hills, small valleys and steep ravines, swamps, rivers and small streams, perennial and seasonal springs. The reserve forest supported subtropical evergreen to semi evergreen vegetation with bamboo as the main secondary growth. Soils are residual in the highlands, alluvium in the riparian zones, and peaty soil in the swamps. This region has a warm and humid climate with 2,000–2,700 mm annual rainfall with temperature and relative humidity ranging from 12–34 °C and 52%–92%, respectively. The reserve forest was fringed by several tea gardens ranging from 1–266 ha, and a number of villages. ILRF also harbored settlements of indigenous tribes such as Reang, Mizo, Kuki, H'mar, Jaintia (P'nar), Veiphei and Dimasa. Other groups, including Bengali Hindu and Muslim, tea garden worker communities (now joined as "tea tribes") and north Indian communities were settled in this reserve forest by the British government of India beginning in 1903 to serve as forest labor. Settlement in the reserve forest was made in the form of clusters of what are officially termed "forest villages" (FVs) to distinguish them from the other "revenue villages" or "villages". There were 22 forest department notified FVs in the ILRF.

Forest village selection

Of the 22 forest villages in the ILRF, seven were predominantly inhabited by tribal groups, five by non-tribals, and ten by mixed populations of tribals and non-tribals. Accordingly, approximately 40% of the villages were selected on the basis of their demographic composition as follows: three tribes, two non-tribes, and four with mixed populations. Inhabitants of these forest villages comprised several tribes of Mongoloid origin (*viz.*, Halem, Jaintia (P'nar), Riang, Mizo, H'mar, Dimasa and Kuki) and non-tribals from north India, southwest West Bengal, Orissa, eastern Bihar and Chhattisgarh. Nine forest villages were Nagathal FV (24°36′38.14″ N and 92°45′21.55″ E) ; Balichuri FV (24°37′01.24″ N and 92°45′19.27″ E), Ekarthal FV (24°37′13.89″ N and 92°45′27.84″ E), Santocherra FV (24°37′13.89″ N and 92°46′17.50″ E), Borosalganga FV (24°37′37.32″ N and 92°46′39.84″ E), Chotosalganga FV (24°37′48.69″ N and 92°46′33.25″ E), Khulicherra FV (24°35′14.72″ N and 92°49′45.51″ E), Khulicherra Mizo Section FV (24°35′3.70″ N and 92°49′36.58″ E), and Seorarthal FV (24°35′2.12″ N and 92°50′44.87″ E).

Participatory rural appraisal

Information on local name, purpose of use and parts used, presence/absence in the forest near a given village, and collection procedure and period for each NTFP was compiled from the selected forest villages by participatory interaction method. Focal group discussions were conducted in each forest village, taking care to include representatives from every ethnic group, with structured and semi structured (open-ended) questionnaires. The respondents (n=654) included the headmen (village chiefs), other knowledgeable persons, NTFP collectors, traders, hunters, traditional medical practitioners, and women. Separate, informal discussions were conducted to document the knowledge base of women in the reserve forest. This was because women often felt constrained or were not allowed to take part in larger, more formal group discussions. Besides, we also interviewed officials such as the District Forest Officer, Cachar, the Forest Range Officer, the Forest Beat Officer, and other forest officials (Forester–I) of different ranges and beats of ILRF.

Frequency of occurrence (%) of NTFP-yielding plants and animals

Twenty-one belt transects (1000 m × 10 m) for trees and animals, and forty-six quadrats (5 m^{-2} for herbs and shrubs, and 10 m^{-2} for climbers, rattan and bamboo) were sampled to estimate percent frequency of occurrence. These transect and quadrats were distributed in the NTFP-collection areas that are located between and near the nine FVs.

NTFP (plant and animal) specimen collection and identification

Local NTFP collectors who were well-versed in the distribution of NTFPs accompanied us in the field survey to provide first-hand, on-site information on plant and animal NTFPs. Information about NTFPs mentioned in the interviews was also collected during forest walks, and voucher specimens and photo-

graphs of plants and animals were collected whenever possible. Village markets were regularly surveyed to record the presence of NTFPs and collect information on local trade. Major collectors were also interviewed to estimate the volume of large scale trade. The study spanned four years (2006–2009) for several reasons. First, the villages and the forest area in general were almost inaccessible during the rainy season of May–October. This reduced the effective time for conducting field surveys and interviews and discussions with respondents to about six months. In 2007, early floods in April and then in July further curtailed the contact period. It was, therefore, thought necessary to collect information of NTFP use over an extended period of four years so as not to miss any NTFP-yielding plant or animal taxa and to record their patterns of use in a more comprehensive manner. This also enabled verification of data, which was expected to lend greater accuracy to the study. Plant and animal species were identified using standard keys (Kanjilal et al. 1934–1940; Raunkiaer 1934; Poffenberger et al. 1992; Moulik 1997; Sahani 1998; Choudhury 1997 and 2000) and by consulting experts in the Botanical and Zoological Surveys of India and other taxonomists.

Results and discussion

Forest dwellers of the ILRF collected 67 plant NTFPs of 40 families and 21 animal NTFPs of 3 phyla and 6 classes (Appendix 1 and 2). Among plants, the highest number of NTFPs was extracted from trees (48%), followed by bamboos and rattans, herbs, climbers, and shrubs (18%, 16%, 12% and 6%, respectively). Among animals, mammals (42%) accounted for most, followed by birds (29%), reptiles (14%), and amphibians, gastropods and crustaceans (5% each). Twenty-one species of plants including 14 tree species were exploited for trade in local, regional and even international markets, the latter including *Glycyrrhiza glabra*, *Smilax lanceaefolia, Homalomena aromatica, Aquilaria malaccensis* and *Citrus macroptera*. The remaining 46 species were harvested only for self-consumption (Fig. 1). India as a whole has some 3,000 NTFP species, of which only 126 (4%) have developed commercial markets (Maithani 1994). In contrast, 21 plant species were commercially exploited in ILRF, accounting for 31.3% of all plant NTFP species in this area. This underscores the importance of this forest to the local economy. Among the commercially harvested species, *Dipterocarpus turbinatus* (CR) and *Aquilaria malaccensis* (VU) are globally threatened per IUCN RedList criteria. Bark of *Litsea sebifera* is extensively used in the essence stick industry. The whole tree is de-barked, resulting in the death of the plant and consequent depletion in the study area. Sometimes de-barking is done after felling the tree (Fig. 2a). Resin is extensively collected from *Canarium bengalensis*, *Canarium resiniferum*, *Litsea* sp. and *Dipterocarpus turbinatus* by making crude incisions on the trunk with the help of a curved broad-blade knife (*dao*), to ensure resin flow (Fig. 2b). Repeated incisions one above the other in the trunk for extraction of resin often results in the premature death of the tree (Fig. 2c). Unrestrained and unmanaged harvesting is known to have negative impact on the structure and dynamics of populations (Murali et al. 1996; Muraleedharan et al. 2005) and this can lead to the decline or even disappearance of a plant species, in turn, affecting animals dependent on the plant (Kataki 1983).

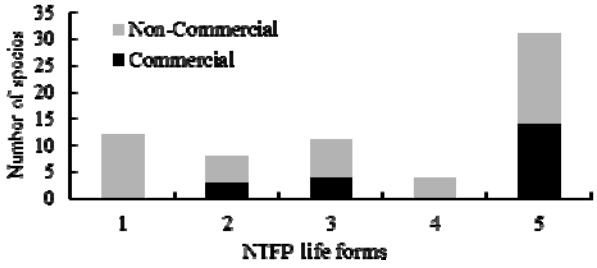

Fig. 1: Commercially and non-commercially used NTFP (plants) in Inner Line Reserve Forest, Assam, India (1: bamboo and rattan; 2: climber; 3: herb; 4: shrub; 5: tree).

Fig. 2: (a) A de-barked *Litsea sebifera* tree; (b) Systematic resin extraction; (c) Unsystematic resin extraction; (d) Stumps of *Lagerstroemia flosreginae* after reclamation of swampy area

In addition to commercial products, NTFPs are extracted from ILRF for subsistence activities such as making agricultural tools and hunting and fishing gears, house construction, and procuring food, medicine, insect repellents, fish poisons and the like. *Lagerstroemia flosreginae* (*jarul*) is the preferred tree species in ILRF for construction of agricultural implements due to its dura-

bility in the wet conditions prevalent during the monsoon season. It is also much sought after for making boats, as its capacity to withstand prolonged inundation is a part of the traditional knowledge in this region (Kutum et al. 2011). Increasing population in the forest villages has led to reclamation of swampy areas in the forest, the main habitat of this species (Fig. 2d). *Lagerstroemia flosreginae* has a long history of intense exploitation in this area, and was consequently one of the few trees on which British foresters imposed harvest restrictions (Hunter 1879). Bamboo and rattan species such as *Daemonorops jenkinsianus* and *Calamus guruba* were extensively used for house construction and for making agricultural tools, hunting and fishing gear, baskets, and mats (Vantomme et al. 2002). Of ten species of bamboo in ILRF, six species, *viz. Bambusa pallida*, *B. assamica*, *B. cacharensis*, *Dendrocalamus hamiltonii*, *Gigantochloa albociliata*, and *B. balcooa* were used for making agricultural tools. *B. balcooa* was rarely used because it was not abundant in the forest. The most common species of bamboo, *Schizostachyum dullooa*, was not suitable for making agricultural implements because of its thin wall and its vulnerability to fungal infections when in contact with water and wet soil. However, *Schizostachyum dullooa* was the species of choice for making fishing and hunting gear, cages, baskets, other household items and decorative pieces, because of its high elasticity that made it more pliable for fashioning into various shapes. Furthermore, its supple nature made it easy for women, children, and even the old and the infirm to handle and manipulate. Thus, this species can provide viable livelihood opportunities to the entire family, where each family member can contribute to total earnings. Another unique and culturally distinct use of *Schizostachyum dullooa* was in the preparation of *chunga peetha*, which is rice cooked inside this bamboo between its long internodes. Cooking inside the bamboo lends a distinct flavor and taste to the rice, which is favored as a local delicacy when taken with dry or fresh fish, meat, especially bush meat, and even milk. Bamboo and cane harvesting parties going on trips into the forest that could last 3–4 days or more, often carry the required number of bamboo pieces filled with rice with the openings plugged with rags. Each piece can then be cooked during a meal. *Schizostachyum dullooa* flowers at intervals of 48 years in Cachar (Nath and Das 2010), and was undergoing flowering since April 2009, leading to obvious problems for the forest dwellers and other villagers, especially the artisans. Another bamboo species, *Melocanna baccifera* was only beginning to regenerate after an extensive flowering period from September to December 2008, although occasional flowering was observed since April 2008 between Loharband and Nagathal FVs at 24°36′10.40″ N and 92°44′12.31″ E. The flowering of this bamboo has traditionally been associated with famine and rat infestations in the neighbouring state of Mizoram. Unsustainable harvesting of the young shoots of several bamboo species for food was also believed to have had adverse effects on their regeneration. Nevertheless, the most obvious cause of bamboo depletion, especially that of *Gigantochloa albociliata* and *Melocanna baccifera* in ILRF was their over-harvest for supply of raw materials to Cachar Paper Mill of Hindustan Paper Corporation (HPC) at Panchgram in the neighbouring Hailakandi district of Assam, only about 70 km from ILRF. The other important NTFPs from a subsistence point of view included edibles such as *Dioscorea* sp. and *Alpinia allughas*, which were food insurances for the forest dwellers, especially during lean economic periods. *Alpinia allughas* was also believed to be a remedy for fever and even malaria.

Fuel wood was extracted from 12 tree species and a shrub *Melastoma malabathricum*. The latter is an initial successor during secondary succession in abandoned shifting cultivation (*Jhum cultivation*) plots and degraded forest (Shukla and Ramakrishnan 1984). Its low height (1 to 1.5 m) enables easy harvesting of twigs and branches, and it is consequently preferred by women fuelwood collectors. In the absence of alternative fuels such as liquid petroleum gas (LPG), kerosene oil or smokeless stoves that consume less fuel wood and are promoted by the Ministry of Rural Development, Government of India, firewood burning in traditional earthen stoves exerts a high demand on the forest resources of ILRF. There are attendant health hazards from carbon monoxide within the confined spaces of village households, more so to the women who often suffer anemia.

NTFPs of animal origin that are harvested or hunted from the forest were mostly for non-commercial purposes such as bush meat, medicine, magico-religious use, and as trophies or pets. Procuring food was a major motivation for hunting of 20 of the 21 species of NTFP-yielding animals. This was followed by hunting for sport and trophy and for magico-religious use. Several NTFP animals were globally threatened per the IUCN Red List. *Hoolock hoolock*, *Indotestudo elongata* and *Manis pentadactyla* were Endangered (EN), *Nilssonia hurum* and *Rusa unicolor* were Vulnerable (VU), and *Buceros bicornis* and *Viverra zibetha* were listed as Low Risk Near Threatened (LR-NT). Among these, a male *Rusa unicolor* was last sighted in the forest in November 2006 and was killed for meat and trophy. As revealed in the focal group discussion, all attempts by the Balichuri FV headman failed to prevent the killing of the animal. Hunting of animals typically increased in winter when the jungles were more accessible. Winter was also the season when people ate the meat of porcupine, deer, pangolin and wild boar, partly because of the belief that consumption of meat lends resistance to cold. Large amounts of fish and meat, including bush meat, were consumed especially on and around the winter solstice in the second week of January, which was celebrated as the “festival of feasts” in this area.

Besides listing the diversity of plant and animal NTFPs in the Inner Line Reserve Forest, our results underscore the dependence of the forest dwellers on this living resource for their livelihood and subsistence. NTFPs such as bamboo and cane from this forest also supported regional industries such as paper and pulp mills and cane furniture units. A comprehensive NTFP policy is needed to strike a balance between biodiversity conservation in the forest and provision of livelihood security to the forest dwellers. Both *in situ* and *ex situ* cultivation and conservation of NTFP-yielding plants, and habitat protection and restoration for animals, are likely to help in addressing the conflicting demands of conservation and livelihood.

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References

Boot RGA. 1997. Extraction of non- timber forest products from tropical rain forests. Does diversity come at a price? *Netherland Journal of Agricultural Science*, **45**(4): 439–450.

Choudhury A. 1997. *Checklist of the Mammals of Assam*. Guwahati: Gibbon Books, p. 103.

Choudhury A. 2000. *The Birds of Assam*. Guwahati: Gibbon Books and WWF, p. 240.

Dattagupta S, Gupta A, Ghose M. 2010. Non-Timber Forest Products of the Inner Line Reserve Forest, Cachar, Assam, India: dependency and usage pattern of forest dwellers. *Assam University Journal of Science and Technology: Biological and Environmental Sciences*, **6**(1): 21–27.

De Beer JH, McDermott MJ. 1996. *The Economic Value of Non-Timber Forest Products in South East Asia.* Amsterdam: The Netherlands Committee for IUCN, p. 197.

Emery MR. 1998. *Invisible livelihoods: non timber forest products in Michigan's Upper Peninsula*. New Brunswick: Rutgers University.

Food and Agricultural Organization (FAO). 1995. Non Wood Forest Products for Rural Income and Sustainable Forestry. *Non-Wood Forest Products*. 7:127. Ref ID- 16 Food and Agricultural Organization, Rome, Italy. Available at: http://www.fao.org/docrep.

Gupta A. 2000. Forests of Barak Valley, Assam: history, management and status as wildlife habitats. *In*: A. Arunachalam, M.L.Khan (eds), *Sustainable Management of Forests–India.* Dehradun: International Book Distributors, pp. 197–212.

Hegde R, Suryaprakash S, Achoth L, Bawa KS. 1996. Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India, 1: contribution to rural income. *Economic Botany*, **50**(3): 243–250.

Hunter WW. 1879. *A Statistical Account of Assam. Vol.2*. Guwahati: Spectrum Publications, p. 490.

Iqbal, M. 1993. *International Trade in Non-Wood Forest Products*. *An Overview*. FO: Misc/93/11 Working Paper. Food and Agricultural Organization of the United Nations, Rome. Available at: http://www.fao.org/docrep/v9631e/V9631e08.htm.

Joshi NR, Singh V. 2010. Non-Timber Forest Products (Ntfps) used by Tharu tribe of Kanchanpur District of Far-Western Nepal. *New York Science Journal*, **3**(11): 111–119.

Kanjilal UN, Das A, Kanjilal PC. 1934-1940. *Flora of Assam.* Delhi: Avon Book Company, Vol I, p.184; Vol II, p. 409; Vol III, p. 578; Vol IV, p. 377; Vol V, p. 480.

Kataki SK. 1983. Some rare plants in Khasi and Jaintia Hills of Meghalaya. *In*: SK Jain, RR Rao (eds), *An Assessment of Threatened Plants of India*. Howrah, India: Botanical Survey of India, pp. 146–150.

Kutum A, Sharma R, Hazarika D. 2011. An ethnobotanical study of Mishing tribe living in fringe villages of Kaziranga National Park of Assam, India. *Indian Journal of Fundamental and Applied Life Sciences*, **1**(4): 45–61.

Maithani GP. 1994. Management perspectives of minor forest produce. *MFP News*, October–December.

Ministry of Environment and Forests. 2010–2011. *Report to the People on Environment and Forest*. Government of India, p. 34.

Mishra M, Kotwal PC, Prasad C. 2009. Harvesting of medicinal plants in the forest of Central India and its impact on quality of raw materials: a case of Nagpur District, India. *Ecoprint*, **16**: 35–42.

Mohammed GH. 1999. *Non-timber forest products in Ontario: an overview*. Ontario Ministry of Natural Resources, Ontario Forest Research Institute, Sault Ste. Marie, Ontario. Forest Research Information Paper No. 145, p. 64.

Moulik S. 1997. *The Grasses and Bamboos of India*. Vol-2. New Delhi: Scientific Publication, p. 700.

Muraleedharan PK, Sasidharan N, Kumar BM, Sreenivasan MA, Sreethalakshmi KK. 2005. Non-timber forest products in the Western Ghats of India: floristic attributes, extraction and regeneration. *Journal of Tropical Forest Science*, **17**(2): 243–257.

Murali KS, Uma Shankar, Uma Shaanker R, Ganeshaiah KN, Bawa KS. 1996. Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India. 2. Impact of NTFP extraction on regeneration, population structure, and species composition. *Economic Botany,* **50**(3): 252–269

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, **403**: 853–858.

Nath AJ, Das AK. 2010. Gregarious flowering of a long-lived tropical semelparous bamboo *Schizostachyum dullooa* in Assam. *Current Science*, **99**(2): 154–155.

Pandey RK, Saini SK. 2007. Edible plants of tropical forests among tribal communities of Madhya Pradesh. *Indian Journal of Traditional Knowledge*, **6**(1): 185–190.

Poffenberger M, McGean B, Ravindranath NH, Gadgil M. 1992. *Field Methods Manual Vol I. Diagnostic Tools for Supporting Joint Forest Management Systems*. New Delhi: Society for promotion of wasteland development, p. 101.

Raunkiaer C. 1934. *The life forms of plants and statistical plant geography*. Oxford: The Clarendon Press, p. 632.

Sahani KC. 1998. *The Book of Indian Trees*. Bombay: Oxford University Press, p. 230.

Shiva MP. 1995. Collection, Utilization and Marketing of Medicinal Plants from Forests of India. *In*: PB Durst, A. Bishop (eds), *Beyond Timber: Social, Economic and Cultural Dimensions of non- Wood Forest Products In Asia and the Pacific*. Rome: FAO, pp. 271–281.

Shukla RP, Ramakrishnan PS. 1984. Biomass allocation strategies and productivity of tropical tree related successional status. *Forest Ecology and Management*, **7**: 119–132.

TERI. 2004. *Sustainable exploitation, cultivation and marketing linkage of Non- Timber Forest Products (NTFPs) in Andhra Pradesh*. Project Report No-2003 SF 63. Available at: http://forest.ap.nic.in/JFM%20CFM/CFM/Special%20Reports/NTFPs%20in%20AP%20%20by%20TERI/NTFP%20Final%20Report%20July-04.pdf.

Ticktin T. 2004. The ecological consequences of harvesting non-timber forest products. *Journal of Applied Ecology,* **41**(4): 11–21.

Uma shaanker R, Ganeshaiah KN, Krishnan S, Ramya R, Meera C, Aravind NA, Kumar A, Rao D, Vanaraj G, Ramachandra J, Gauthier R, Ghazoul J, Poole N, Chinnappa Reddy BV. 2004. Livelihood gain and ecological cost of non-timber forest product dependence: assessing the roles of dependence, ecological knowledge and market structure in three contrast-

ing human and ecological settings in South India. *Environmental Conservation*, **31**(3): 242−253.

Uprety Y, Boon EK, Poudel RC, Shrestha KK, Rajbhandary S, Ahenkan A, Tiwari NN. 2010. Non-timber Forest Products in Bardiya District of Nepal: Indigenous Use, Trade and Conservation. *Journal of Human Ecology*, **30**(3): 143−158.

Vantomme P, Markkula A, Leslie RN. 2002. Non-wood forest products in 15 countries of tropical Asia: an overview. EC-FAO partnership programme (2000−2002), Project GCP/RAS/173/EC, p. 200.

Vasquez R, Gentry AH. 1989. Use and misuse of forest harvested fruits in the Iquitos area. *Conservation Biology*, **3**(4): 350−361.

Appendix 1: Diversity of non-timber forest products (plants) in Inner Line Reserve Forest, North East India

Species	Forest village*	FO (%)	Parts used	Harvesting period season
Bambusa pallida Munro	BC; NT; BS; SC; ST.	6.7	Culm: house construction, agricultural tools, fishing gear; Leaf: roofing material; Shoot: edible	Jan. to Dec. (Shoot: May to Aug.)
Bambusa assamica Barooah & Borthakur	NT; BS; CS; SC; ST.	3.4	Culm: house construction, agricultural tools, fishing gear	Jan. to Dec. (Shoot: May to Aug.)
Bambusa balcooa Roxb.	NT; BS; CS; SC; KC; KCM; ST; ET.	1.3	Culm: house construction; Shoot: edible	Jan. to Dec. (Shoot: May to Aug.)
Bambusa cacharensis R. Majumder	BC; NT; BS; CS;SC; KC; KCM; ST;ET.	2.8	Culm: house construction; agricultural tools; Shoot: edible	Jan. to Dec. (Shoot: May to Aug.)
Dendrocalamus hamiltonii Nees &Arn. *ex* Munro	NT; BS; CS; SC; KC; KCM; ST; ET.	6.7	Culm: house construction, agricultural tools, fishing gear; Shoot: edible	Jan. to Dec. (Shoot: May to Aug.)
Dendrocalamus strictus (Roxb.) Nees	NT.	3.4	Culm: House construction, Duster handle	Jan. to Dec.
Dinochloa compectiflorus (Kurtz.) Benth	NT.	7.4	Culm: House construction	Jan. to Dec.
Gigantochloa albociliata (Munro) Kurz	BC; NT; BS; CS; SC; KC; KCM; ST;ET.	10.7	Culm: house construction, agricultural tools, fishing gear	Jan. to Dec. (Shoot: May to Aug.)
Melocanna baccifera Kurz.	NT; BS; CS; SC; KC; KCM; ST; ET.	10.1	Culm: house construction, agricultural tools, fishing gear; Leaf: roofing material; Shoot: edible	Jan. to Dec. (Shoot: May to Aug.)
Schizostachyum dullooa (Gamble) R. Majumder	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	18.8	Culm: house construction, container for cooking rice	Jan. to Dec.
Calamus guruba Griff	BC; NT; SC; KCM; ST.	17.4	Stem: furniture, fishing, hunting gear, agricultural tool	Jan. to Dec.
Daemonorops jenkinsianus Griff	BC; NT; BS; CS; SC; ET.	11.4	Stem: furniture, fishing, hunting gear, agricultural tool	Jan. to Dec.
Asparagus racemosus Willd	BC; NT; ET.	32.6	Root: medicinal	Dec. to Mar.
Dioscorea sp.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	69.6	Root: edible	Jan. to Dec.
Entada phaseoloides (L.) Merr.	NT; BS; CS; SC; KC; ST; KCM; ET.	30.4	Seed: medicinal, magico- religious	Nov. to Mar.
Glycyrrhiza glabra Linn	BC; NT; BS; SC; ET.	32.6	Root: medicinal, traditional wine making	Dec. to Mar.
Luffa cylindrica (L.) Robx.	BC; NT;BS; CS;SC; KC; KCM; ET.	39.1	Fruit: vegetable, bath sponge	Jun. to Sep.
Mikania cordata (Burm. f.) B.L. Robins.	BC; NT;BS; CS; SC; KC; KCM; ST; ET.	89.1	Leaf: medicinal	Jan. to Dec.
Pericamphylus incanus (Colebr.) Meirs	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	73.9	Stem: house construction	Jan. to Dec.
Smilax lanceaefolia Roxb.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	95.6	Root: medicinal, traditional herbal tea	Dec. to Mar.
Alpinia allughas Rosco	NT; BS; CS; SC; KC; ST; KCM.	39.1	Stem: vegetable	Apr. to Sep.
Centella asiatica (L.)	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	71.7	Leaf: medicinal	Jan. to Dec.
Cynodon dactylon (L.) Pers.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	65.2	Leaf: medicinal, religious, rights , reticules	Jan. to Dec.
Homalomena aromatica (Spreng.) Schott	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	78.3	Root: medicinal, essence, traditional gunpowder, local delicacy “Chutney”	Oct. to Mar.
Imperata cylindrica (L.) P. Beauv.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	47.8	Leaf: roofing material	Jan. to Feb.

Continued Appendix 1

Species	Forest village*	FO (%)	Parts used	Harvesting period season
Licuala peltata Roxb.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	54.3	Leaf: roofing material for house, traditional umbrella	Jan. to Mar.
Musa balbisiana Colla	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	41.3	Inflorescence: vegetable	Jan. to Dec.
Oxalis corniculata L.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	73.9	Leaf: medicinal	Jan. to Dec.
Phrynium sp.	BC; NT; BS; SC; KC; ST; ET; KCM.	54.3	Leaf: packing material	Jan. to Dec.
Saccharum arundinaceum Retz	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	69.6	Stem: house construction	Dec. to Mar.
Thysanolaena latifolia (Roxb. Ex Hornet.) Honda	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	34.8	Inflorescence: broom	Jan. to Feb.
Adhatoda vasica Nees	BC; NT; BS; CS;SC; KC; KCM; ST; ET.	69.6	Leaf : medicinal	Jan. to Dec.
Hibiscus sabdariffa L.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	56.5	Fruit: vegetable, pickle	Dec. to Jan.
Melastoma malabathricum L	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	78.3	Branches: fire wood; Fruit: dye	Jan. to Dec.
Rauvolfia serpentina (L.) Benth. *ex* Kurz	NT.	2.2	Root: medicinal	Jan. to Dec.
Acacia pennata (L.) Willd.	BC; NT;BS; CS; SC; KC; KCM; ST; ET.	87.5	Branches: fire wood	Jan. to Dec.
Albizia lebbeck (L) Benth	BC; NT;BS; CS; SC; KC; KCM; ST; ET.	95.2	Branches: fire wood	Jan. to Dec.
Anthocephalus chinensis (Lamk) Rich *ex* Walp.	BC; NT;BS; CS; SC; KC; KCM; ST; ET.	71.4	Branches: fire wood ; Stem: magi co-religious	Jan. to Dec.
Aquilaria malaccensis Lam.	NT; ET; BC.	28.5	Resin: essence	Jan. to Dec.
Ardisia solanacea Robax.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	71.4	Branches: fire wood	Jan. to Dec.
Azadirachta indica A Juss	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	52.4	Branches: fire wood ; Leaf: medicinal	Jan. to Dec.
Canarium bengalensis Roxb.	NT; BS; CS; SC; KC; KCM; ET.	57.1	Resin: essence, insect repellent	Dec. to Mar.
Canarium resiniferum Brace ex King	BC; NT; BS; CS; SC; KCM; ET.	80.9	Resin: essence, insect repellent	Dec. to Mar.
Cinnamomum zeylanicum Breyn	BC; NT; BS; SC; KC; KCM; ST; ET	85.7	Leaf: condiment	Jan. to Apr.
Citrus macroptera Lour	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	76.2	Fruit: vegetable, condiment, medicinal, essence	Aug. to Sep.
Dillenia indica L.	BC; NR; BS; CS; SC; KC; KCM; ST; ET.	85.7	Fruit: vegetable, pickle; Leaf: insect repellent	Jun. to Sep.
Dipterocarpus turbinatus Gaertn.f.	NT	23.8	Branches: fire wood; Resin: essence, insect repellent	Dec. to Feb. (Resin); Jan. to Dec. (Fire wood)
Ficus hispida L.	BC; NT; BS; CS; SC; KC; KCM; ST; ET	80.9	Stem and branches: fire wood	Jan. to Dec.
Gmelina arborea Robax.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	57.1	Stem and branches: fire wood	Jan. to Dec.
Gynocardia odorata R.Br.	NT; SC	33.3	Fruit: medicinal, fish poison	Jan. to Mar.
Hydnocorpus kurzi (King) Warb.	NT; BS	19.0	Fruit: medicinal, fish poison	Jan. to Mar.
Lagerstroemia flosreginae Roxb.	NT; KC; KCM; ST.	23.8	Branches: agricultural tool, fire wood	Jan. to Dec.
Litsea sebifera Pers	BC; NT; BS; CS; ST; ET.	80.9	Bark: essence stick pulp, medicinal	Dec. to Mar.
Litsea sp.	NT; BS; CS; SC; KCM.	61.9	Resin: essence, insect repellent	Dec. to Mar.
Macaranga denticulata (BL.) Muell. Arg.	BC; NT;BS; CS; SC; KC; KCM; ST; ET.	76.2	Branches: fire wood; leaf: packing material	Jan. to Dec.
Mesua ferrea L	BC; NT; BS; CS; SC; ST; ET.	71.4	Flower: essence, medicinal	Apr. to Jun.

Continued Appendix 1

Species	Forest village*	FO (%)	Parts used	Harvesting period season
Perkia trimoriana (DC.) Merr.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	90.4	Fruit: vegetable	May to Oct.
Sapindus mukorossi Gaertn.	BC; NT; CS; SC; KCM; ST	61.9	Fruit: shampoo	Mar. to Apr.
Saraca asoca (Roxb) De Wild	NT; SC.	42.8	Bark: medicinal	Jan. to Dec.
Sterculia villosa Roxb.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	80.9	Bark: rope making	Jan. to Dec.
Streblus asper Lour.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	71.4	Branch and Leaf: medicinal, religious	Jan. to Dec.
Tamarindus indicus L.	BC; NT; BS; CS; SC; KC; KCM; ST.	66.7	Fruit: medicinal, pickle; Branches: fire wood	Jan. to Dec. (Fire wood)
Tectona grandis L. *f.*	BC; NT; BS; CS; SC; KC; ST; ET.	52.4	Stem and branches: fire wood	Jan. to Dec.
Terminalia arjuna (Roxb.ex Dc.) Wight & Arn.	NT; CS; ST; ET.	57.1	Bark: medicinal, dye	Dec. to Mar.
Terminalia bellirica (Gaertn.f.) Roxb.	NT; BS;CS; SC;ST; ET.	61.9	Fruit: medicinal, dye	Dec. to Jan.
Terminalia chebula Retz.	NT; CS; SC; ST; ET.	61.9	Fruit: medicinal, dye	Dec. to Jan.
Tetrameles nudiflora R.Br.	BC; NT; BS; CS; SC; KC; KCM; ST; ET.	61.9	Stem and branches: fire wood	Dec. to Jan.

* FO-Frequency of occurrence; BC-Balichuri; BS-Borosalganga; CS- Chotosalganga; ET-Ekarthal; KC- Khulicherra; KCM- Khulicherra Mizo section; NT- Nagathal; SC-Santocherra; ST-Seorarthal

Appendix 2: Diversity of non-timber forest product (animals) in Inner Line Reserve Forest, North East India

Scientific name	English name	IUCN status	FO %	Parts Used	Hunting period
Unidentified	Crab		27.6	Soft tissue: edible	Dec. to Mar.
Brotia (Antimelania) costula (Rafinesque 1833)	Snail		23.0	Soft tissue: edible, medicine	Dec. to Mar.
Hoplobatrachus tigerinus (Daudin 1803)	Indian bullfrog	LC	6.3	Flesh: edible	May to Aug.
Nilssonia hurum (Gray 1833)	Indian peacock softshell turtle	VU	5.6	Meat and eggs: edible; Carapace: trophy	Apr. to Oct.
Indotestudo elongata (Blyth 1853)	Yellow-headed tortoise	EN	1.6	Meat: edible; Carapace: trophy	Mar. to Aug.
Varanus bengalensis (Daudin 1802)	Bengal monitor lizard		1.6	Meat: edible	Apr. to Oct.
Buceros bicornis (Linnaus 1758)	Great Indian Hornbill	NT	47.0	Meat: edible; Bill and cranium: trophy, magico- religious	Jan. to Dec.
Dendrocygna javanica (Horsfield 1821)	Lesser whistling Duck	LC	4.8	Meat: edible	Jan. to Mar.
Gallus gallus (Linnaeus 1758)	Red Jungle fowl	LC	8.7	Meat: edible	Jan. to Mar.
Gracula religiosa (Linnaeus 1758)	Hill myna	LC	48.4	Live bird: pet	Mar. to May
Polyplectron bicalcaratum (Linnaeus 1758)	Peacock-pheasant	LC	4.6	Meat: edible: Feather: trophy	Jan. to Dec.
Psittacula krameri (Scopoli 1769)	Rose-ringed Parakeet	LC	43.6	Meat: edible, medicine, pet	Jan. to Dec.
Callosciurus erythraeus (Pallas 1779)	Pallas's squirrel	LC	18.2	Meat: edible; Whole body: trophy	Jan. to Dec.
Rusa unicolor (Kerr 1792)	Sambar	VU	0	Meat: edible; Skin and cranium: trophy	Jan. to Dec.
Funambulus palmarum (Linnaeus 1766)	Common Palm Squirrel	LC	50.8	Meat: edible	Jan. to Dec.
Hoolock hoolock (Harlan 1834)	Western hoolok gibbon	EN	19.0	Meat: edible; Pelt: trophy; Cranium: magico- religious	Jan. to Dec.
Hystrix sp (Linnaeus 1758)	Porcupine		9.5	Meat: edible; Quill: magico- religious, trophy; Intestine: medicinal	Jan. to Dec.
Manis pentadactyla (Linnaeus 1758)	Chinese pangolin	EN	7.9	Meat: edible; Scale and claw: magico- religious	Jan. to Dec.
Muntiacus muntjak (Rafinesque 1815)	Barking deer	LC	11.1	Meat: edible; Skin and cranium: trophy	Dec. to Feb.
Sus scrofa (Linnaeus, 1758)	Wild boar	LC	19.0	Meat: edible, medicine; Head: magico-religious	Dec. to Feb.
Viverra zibetha (Linnaeus1758)	Large Indian Civet	NT	1.6	Meat: edible; Skin: trophy	Dec. to Feb.

FO-Frequency of occurrence